Performance Upgrades to Bending-Magnet Beamline 9.3.1 for Atomic, Molecular, and Materials Science

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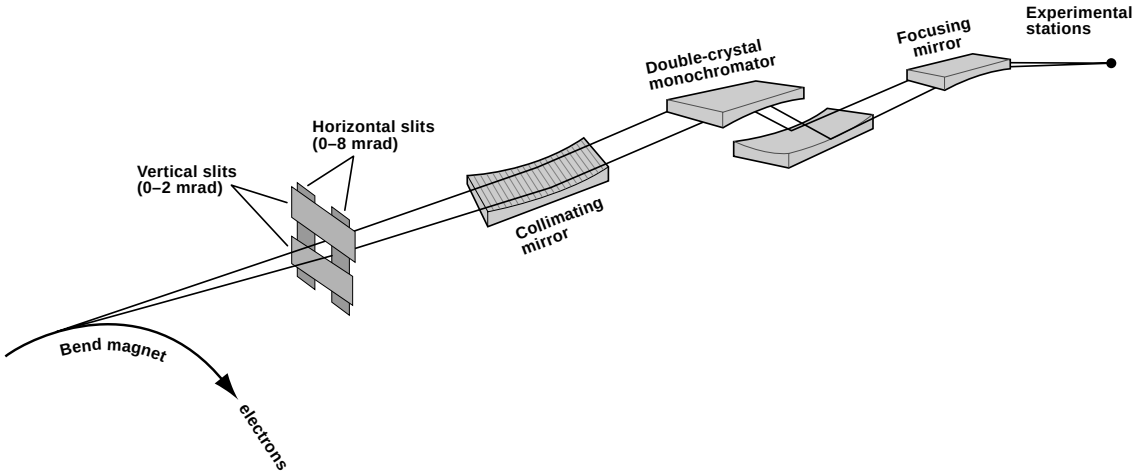
Beamline 9.3.1 is a bending-magnet beamline which provides high-resolution x-ray beams between 2.2 and 6 keV, allowing electron, ion, and x-ray spectroscopy measurements for atomic, molecular, and materials sciences. Because recently proposed experiments require taking the beamline beyond its original design parameters, including beam stability and the photon-energy range, an effort was begun in August 1999 to improve the performance of beamline 9.3.1.



The heart of the beamline is a double-crystal monochromator. The two crystals forming the monochromator ride on a very precise boomerang-type mechanical linkage which keeps the two crystals parallel in both χ and θ directions, where χ can be defined either as a pitch of the crystal holder or a roll about the photon beam axis and θ either as a roll about the crystal holder or a vertical pitch relative to the photon beam-axis. Three sources of unwanted beam motion were due to the monochromator itself. The first source requires a simple χ adjustment of the second crystal, making the crystal faces parallel in a plane perpendicular to the photon-beam axis. Uncorrected this error causes the photon beam to walk horizontally when the photon energy is changed. While making this correction it was observed that adjustments in χ also changed θ slightly in a previously unobserved coupling of the two axes of motion. A change in θ affects the 2d spacing (Bragg's law) of the crystal resulting in destructive interference or loss of photon flux. To remove this cross-talk between the χ and θ adjustments, new crystal holders have been designed that place the χ adjustment on the first crystal and leaving the θ adjustment on the second crystal, effectively separating the two piezo-electric motors. The new crystal holders will be installed during the June 1999 shutdown. The second source of beam motion was found to be a flaw in the precision boomerang supporting the two crystals. This source caused the observed photon beam to walk erratically (χ and θ) in a few specific photon-energy ranges. The correction of this source was completed in January 1999 and required replacement of the precision

boomerang. The final source of unwanted beam motion occurs just after a storage ring refill, is time dependent, and is defined by the photon beam walking horizontally and walking a minor amount vertically for the first few minutes after the refill. This is due to the heating of the monochromator crystals causing them to be misaligned until reaching their final operating temperature. Misalignment also causes the 2d spacing between the crystals to change, resulting in incorrect spacing between the crystals when a photon energy scan is performed, leading to a rise and drop in photon flux as the crystals move in and out of the optimal crystal spacing, effectively causing a shortening of the range in a particular photon energy scan at low energies. The solution to this is passive cooling of the first crystal, and required the purchase of thin Si (111) crystals to allow for rapid heat transfer. The new crystals and cooling mechanism are to be placed in the new crystal holders and will be installed during the June 1999 shutdown.

Finally, a second set of crystal holders was constructed for a pair of recently purchased Ge (111) crystals. The new crystals will triple the flux provided by the Si (111) crystals and lower the minimum photon energy to nearly 2.0 keV. However, they will also reduce the photon resolution by a factor of three.

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